

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1      Claim 1 (currently amended): A method of determining an optimum bit load per subchannel  
2      in a multicarrier system with forward error correction, comprising:

3            computing one or more values of a number of bit positions  $b$  of a  
4            quadrature-amplitude-modulation symbol, a maximum number of symbol errors that can  
5            be corrected  $t$ , and based on one or more values of a number of symbols in the  
6            information field  $K$ , and one or more values of a number of control code symbols per  
7            discrete-mult-tone symbol  $z$ , to provide one or more determined values of  $b$ , to determine  
8            the optimum bit load per subchannel in accordance with the following relationship:

$$1 - \left( 1 - W(s, z, K) \varepsilon_s^{\frac{1}{0.5 \cdot sz + 1}} \right)^{1/\alpha} \\ = \omega(b(\gamma_{\text{eff}}, s, z)) \left( 1 - 2^{-b(\gamma_{\text{eff}}, s, z)/2} \right) \operatorname{erfc} \left( \sqrt{3 \cdot 10^{\gamma_{\text{eff}}/10} / (2^{b(\gamma_{\text{eff}}, s, z)+1} - 2)} \right), \text{ and} \\ \times \left[ 2 - \left( 1 - 2^{-b(\gamma_{\text{eff}}, s, z)/2} \right) \operatorname{erfc} \left( \sqrt{3 \cdot 10^{\gamma_{\text{eff}}/10} / (2^{b(\gamma_{\text{eff}}, s, z)+1} - 2)} \right) \right]$$

$$W(s, z, K) = \left[ \frac{\Gamma(K + s + sz)}{\Gamma(K + s + 0.5 \cdot sz) \Gamma(0.5 \cdot sz + 1)} \right]^{-1/(0.5 \cdot sz + 1)}$$

$$W(s, z, K) = \left[ \frac{\Gamma(K + \rho s + sz)}{\Gamma(K + \rho s + 0.5 \cdot sz) \Gamma(0.5 \cdot sz + 1)} \right]^{-1/(0.5 \cdot sz + 1)}$$

$$\text{wherein } \omega(b) = \frac{4}{2b + 3},$$

16

17 |  $I(x) = (x-1)!$ , and

18

19 |  $b(\gamma_{eff}, s, z) = \frac{\alpha}{sn_{eff}} (K + \rho s + zs)$

20

21 | s represents a number of discrete-multi-tone symbols in a frame,  $\epsilon_s$  represents a symbol  
22 | error rate,  $\alpha$  represents the size of a code symbol,  $\rho$  represents a framing mode index,  $z$   
23 | represents a number of control code symbols per discrete multi-tone symbol,  $b$  represents  
24 | a number of bit positions of a quadrature-amplitude-modulation symbol,  $\omega(b)$  represents  
25 | an average fraction of erroneous bits in an erroneous  $b$ -sized  
26 | quadrature-amplitude-modulation symbol,  $\gamma_{eff}$  represents an effective signal-to-noise  
27 | ratio, and  $n_{eff}$  represents an effective number of subchannels; and  
28 | selecting the value of  $K$  and the value of  $z$  which provides a maximum number of  
29 | bit positions based on the one or more determined values of  $b$  the maximum number of  
30 | symbol errors that can be corrected  $t$ , and the number of symbols in the information field  
31 |  $K$  such that the uncoded bit error rate  $p_b$  that produces a symbol error rate that is less than  
32 | or equal to the target symbol error rate is increased.

1 | Claim 2 (original): The method of claim 1 wherein the effective signal-to-noise ratio  $\gamma_{eff}$   
2 | is an average signal-to-noise ratio of at least a subset of the channels.

1 | Claim 3 (currently amended): The method of claim 1 wherein the size of the frame ranges  
2 | from 0 to  $N_{max}s-zs$  symbols, where  $N_{max}$  is a predetermined value.

1 | Claim 4 (currently amended): The method of claim 1 further comprising:  
2 | determining a difference  $\Theta(K)$  between a bit error rate prior to decoding and the a  
3 | target bit error rate ( $p_e$ ) based on one or more values of a length of an information field  $K$

4 | within a range from 0 to  $N_{max}\cdot\alpha\cdot s\cdot z_s$ , where  $N_{max}$  is a predetermined value, in accordance  
5 | with the following relationship:

6 |  
7 | 
$$\Theta(K) = \omega(b(\gamma_{eff}, s, z))p_{QAM} - p_e, \text{ and}$$

8 |  
9 | 
$$\begin{aligned} & \omega(b(\gamma_{eff}, s, z))p_{QAM} \\ &= \omega\left(\frac{\alpha}{sn_{eff}}(K + s + zs)\right) \left[ 1 - 2^{-\frac{\alpha}{2sn_{eff}}(K+s+zs)} \right] erfc\left(\sqrt{3 \cdot 10^{\gamma_{eff}/10} / \left(2^{\frac{\alpha}{sn_{eff}}(K+s+zs)+1} - 2\right)}\right) \\ & \quad \times \left[ 2 - \left(1 - 2^{-\frac{\alpha}{2sn_{eff}}(K+s+zs)}\right) erfc\left(\sqrt{3 \cdot 10^{\gamma_{eff}/10} / \left(2^{\frac{\alpha}{sn_{eff}}(K+s+zs)+1} - 2\right)}\right) \right] \end{aligned}$$

10 |  
11 |  
12 | 
$$\begin{aligned} & \omega(b(\gamma_{eff}, s, z))p_{QAM} \\ &= \omega\left(\frac{\alpha}{sn_{eff}}(K + \rho s + zs)\right) \left[ 1 - 2^{-\frac{\alpha}{2sn_{eff}}(K+\rho s+zs)} \right] erfc\left(\sqrt{3 \cdot 10^{\gamma_{eff}/10} / \left(2^{\frac{\alpha}{sn_{eff}}(K+\rho s+zs)+1} - 2\right)}\right) \\ & \quad \times \left[ 2 - \left(1 - 2^{-\frac{\alpha}{2sn_{eff}}(K+\rho s+zs)}\right) erfc\left(\sqrt{3 \cdot 10^{\gamma_{eff}/10} / \left(2^{\frac{\alpha}{sn_{eff}}(K+\rho s+zs)+1} - 2\right)}\right) \right] \end{aligned}$$

13 |  
14 | 
$$p_e = \left[ 1 - \left( 1 - W(s, z, K) \varepsilon_S^{\frac{1}{0.5 \cdot s \cdot z_s + 1}} \right)^{1/\alpha} \right]$$

15 |  
16 | wherein  $p_{QAM}$  represents a probability of error in transmitting a  
17 | quadrature-amplitude-modulation waveform representing a  $2^b$  point constellation, and  $p_e$   
18 | represents a channel symbol error rate; and  
19 | comparing the value of  $\Theta(0)$  and  $\Theta(N_{max}\cdot s \cdot z_s)$  to 0; and  
20 | setting the value of K to a predetermined value in response to the comparing.

1      | Claim 5 (currently amended): The method of claim 4 further comprising: wherein  
2            | when  $\Theta(0) < 0$  and  $\Theta(N_{max}-s-sz) < 0$ , setting  $K = N_{max}-s-zs$ .

1      | Claim 6 (currently amended): The method of claim 4 further comprising:  
2            | setting  $b(\gamma_{eff}, s, z)$  equal to  $(\alpha N_{max})/(s n_{eff})$  for all values of  $\gamma_{eff}$  and  $z$ .

3      | 
$$\frac{\alpha N_{max}}{s n_{eff}}$$

1      | Claim 7 (currently amended): The method of claim 4 wherein when  $\Theta(0) > 0$  and  
2            |  $\Theta(N_{max}-s-sz) > 0$ , setting  $K = N_{max}-1$ .

1      | Claim 8 (currently amended): The method of claim 7 further comprising:  
2            | setting  $b(\gamma_{eff}, s, z)$  equal to  $b(\gamma_{eff}, 1, \theta)$   $s=1$  and  $z=0$ .

1      | Claim 9 (currently amended): A method of selecting forward error correction parameters  
2            | in a channel having a plurality of subchannels in a multicarrier communications system,  
3            | comprising:  
4            | determining a signal-to-noise ratio representing a subset of the subchannels to  
5            | provide said a representative performance measurement;

6            | storing, in a table, the number (s) of discrete multi-tone symbols in a  
7            | forward-error-correction frame, the number (z) of forward-error-correction control  
8            | symbols in the discrete multi-tone symbol associated with the signal-to-noise ratio, and  
9            | the number of subchannels associated with the signal-to-noise ratio, and a net coding gain  
10          | for different values of s, z, signal-to-noise ratios and numbers of subchannels; and  
11          | selecting forward error correction parameters of the channel based on the net  
12          | coding gain by applying an approximation to a subset of values in the table.

1      | Claim 10 (original): The method of claim 9 wherein the approximation is a bilinear  
2            | approximation.

1       Claim 11 (currently amended): A method of selecting forward error correction  
2       parameters in a channel having a plurality of subchannels in a multicarrier  
3       communications system, comprising:

4              determining a signal-to-noise ratio representing a subset of the subchannels to  
5        provide said a representative performance measurement;  
6              storing, in a table, the number (s) of discrete multi-tone symbols in a  
7        forward-error-correction frame, the number (z) of forward-error-correction control  
8        symbols in the discrete multi-tone symbol associated with the signal-to-noise ratio, the  
9        maximum number of transmissions (k) and the number of subchannels associated with  
10      the signal-to-noise ratio, and a net coding gain for different values of s, z, signal-to-noise  
11      ratios and numbers of subchannels; and  
12              selecting forward error correction parameters of the channel based on the net  
13      coding gain by applying an approximation to a subset of values in the table.

1       Claim 12 (original): The method of claim 11 wherein the approximation is a bilinear  
2       approximation.

1       Claim 13 (original): The method of claim 11 wherein and the values of s and z are in  
2       accordance with the G.dmt standard.

1       Claim 14 (original): The method of claim 13 wherein the values of s and z are in  
2       accordance with the G.lite standard, such that a subset of the tables associated with the  
3       values of s and z in accordance with the G.dmt standard are used when the channel uses  
4       the G.lite standard.

1       Claim 15 (original): A method of increasing a bit load of a multicarrier system  
2       comprising a channel having a plurality of subchannels, comprising:  
3              determining a bit load for at least one subchannel based on a target symbol error rate  
4        $\epsilon_s$ , a maximum number of symbol errors that can be corrected  $t$ , a number of symbols in an

5 information field  $K$ , and a maximum number of transmissions  $k$ , and a number of bits per  
6 subchannel; and

7 selecting the maximum number of symbol errors  $t$ , the number of symbols in the  
8 information field  $K$  and the maximum number of transmissions  $k$ , such that a net coding gain  
9 is increased, and wherein  $t$ ,  $K$  and  $k$  are also selected such that no forward error correction is  
10 applied when the number of subchannels exceeds a predetermined threshold number of  
11 subchannels.

1 Claim 16 (original): The method of claim 15 wherein the channel uses the G.dmt  
2 standard.

1 Claim 17 (original): The method of claim 15 wherein the channel uses the G.lite standard.

1 Claim 18 (currently amended): A method of determining an optimum bit load per subchannel  
2 in a multicarrier system with forward error correction, comprising:

3 computing one or more values of a number of bit positions  $b$  of a  
4 quadrature-amplitude-modulation symbol based on one or more values of a number of  
5 symbols in an information field  $K$ , one or more values of a number of control code  
6 symbols per discrete-multi-tone symbol  $z$ , and a maximum number of transmissions  $k$ , to  
7 provide one or more determined values of  $b$ , maximum number of symbol errors that can  
8 be corrected  $t$ , and a number of symbols in the information field  $K$  to determine the  
9 optimum bit load per subchannel in accordance with the following relationship:

$$1 - \left( 1 - W(s, z, K) \varepsilon_s^{\frac{1}{0.5 \cdot sz + 1}} \right)^{1/\alpha}$$
$$= \omega(b(\gamma_{eff}, s, z)) \left( 1 - 2^{-b(\gamma_{eff}, s, z)/2} \right) erfc \left( \sqrt{3 \cdot 10^{\gamma_{eff}/10} / (2^{b(\gamma_{eff}, s, z)+1} - 2)} \right), \text{ and}$$
$$\times \left[ 2 - \left( 1 - 2^{-b(\gamma_{eff}, s, z)/2} \right) erfc \left( \sqrt{3 \cdot 10^{\gamma_{eff}/10} / (2^{b(\gamma_{eff}, s, z)+1} - 2)} \right) \right]$$

$$\begin{aligned}
 & 1 - \left( 1 - W(s, z, K, k) \varepsilon_s^{\frac{1}{k(0.5sz+1)}} \right)^{1/\alpha} \\
 13 & = \omega(b(\gamma_{\text{eff}}, s, z)) \left[ 1 - 2^{-b(\gamma_{\text{eff}}, s, z)/2} \operatorname{erfc}\left(\sqrt{3 \cdot 10^{\gamma_{\text{eff}}/10}} / (2^{b(\gamma_{\text{eff}}, s, z)+1} - 2)\right) \right. \\
 & \quad \times \left. \left[ 2 - \left( 1 - 2^{-b(\gamma_{\text{eff}}, s, z)/2} \operatorname{erfc}\left(\sqrt{3 \cdot 10^{\gamma_{\text{eff}}/10}} / (2^{b(\gamma_{\text{eff}}, s, z)+1} - 2)\right) \right) \right]
 \end{aligned}$$

$$\begin{aligned}
 14 & \\
 15 & W(s, z, K) = \left[ \frac{\Gamma(K + \rho s + sz)}{\Gamma(K + \rho s + 0.5 \cdot sz) \Gamma(0.5 \cdot sz + 1)} \right]^{-1/(0.5 \cdot sz + 1)}
 \end{aligned}$$

$$\begin{aligned}
 16 & \\
 17 & \\
 18 & W(s, z, K, k) = \left[ \frac{\Gamma(K + \rho s + sz)}{\Gamma(K + \rho s + 0.5 \cdot sz) \Gamma(0.5 \cdot sz + 1)} \right]^{-1/(0.5 \cdot sz + 1)} \left[ \frac{\Gamma(K + \rho s + sz + 1)}{\Gamma(K + \rho s + 0.5 \cdot sz) \Gamma(0.5 \cdot sz + 2)} \right]^{-(k-1)/(0.5 \cdot sz + 1)k} \\
 19 & \\
 20 & \text{wherein } \omega(b) = \frac{4}{2b+3}, \\
 21 & \\
 22 & \underline{I(x)=(x-1)!}, \text{ and} \\
 23 & \\
 24 & b(\gamma_{\text{eff}}, s, z) = \frac{\alpha}{sn_{\text{eff}}} (K + \rho s + sz)
 \end{aligned}$$

25  
 26 s represents a number of discrete-multi-tone symbols in a frame, z represents a number of  
 27 control code symbols per discrete multi-tone symbol, b represents a number of bit  
 28 positions of a quadrature-amplitude-modulation symbol,  $\varepsilon_s$  represents a symbol error rate,  
 29  $\alpha$  represents the size of a code symbol,  $\omega(b)$  represents an average fraction of erroneous  
 30 bits in an erroneous  $b$ -sized quadrature-amplitude-modulation symbol,  $\gamma_{\text{eff}}$  represents an  
 31 effective signal-to-noise ratio, and  $\rho$  represents a number of overhead symbols per  
 32 discrete multi-tone symbol framing mode index; and  $n_{\text{eff}}$  represents an effective number of  
 33 subchannels; and

34       selecting the value of  $K$  and the value of  $z$  which provides a maximum number of  
35       bit positions based on the one or more determined values of  $b$  the maximum number of  
36       symbol errors that can be corrected  $t$ , and the number of symbols in the information field  
37        $K$  such that the uncoded bit error rate  $p_b$  that produces a symbol error rate that is less than  
38       or equal to the target symbol error rate is increased.

1       Claim 19 (original): The method of claim 18 wherein the effective signal-to-noise  
2       ratio  $\gamma_{\text{eff}}$  is an average signal-to-noise ratio of at least a subset of the channels.

1       Claim 20 (currently amended): The method of claim 18 wherein the size of the frame  
2       ranges from 0 to  $N_{\max}$ -ps-sz symbols, where  $N_{\max}$  is a predetermined value.

1       Claim 21 (currently amended): The method of claim 18 further comprising:

2       determining a difference  $\Theta(K)$  between a bit error rate prior to decoding and ~~at the~~  
3       target bit error rate ( $p_e$ ) ~~based on one or more values of a length of an information field  $K$~~   
4       ~~within a range from 0 to  $N_{\max}$ -ps-sz, where  $N_{\max}$  is a predetermined value~~, in accordance  
5       with the following relationship:

6

7       
$$\Theta(K) = \omega(b(\gamma_{\text{eff}}, s, z)) p_{QAM} - p_e, \text{ and}$$

8

9       
$$\begin{aligned} & \omega(b(\gamma_{\text{eff}}, s, z)) p_{QAM} \\ &= \omega\left(\frac{\alpha}{sn_{\text{eff}}}(K + \rho s + z s)\right) \left(1 - 2^{-\frac{\alpha}{2sn_{\text{eff}}} (K + \rho s + z s)}\right) \operatorname{erfc}\left(\sqrt{3 \cdot 10^{\gamma_{\text{eff}}/10} / \left(2^{\frac{\alpha}{sn_{\text{eff}}} (K + \rho s + z s) + 1} - 2\right)}\right) \\ & \quad \times \left[2 - \left(1 - 2^{-\frac{\alpha}{2sn_{\text{eff}}} (K + \rho s + z s)}\right) \operatorname{erfc}\left(\sqrt{3 \cdot 10^{\gamma_{\text{eff}}/10} / \left(2^{\frac{\alpha}{sn_{\text{eff}}} (K + \rho s + z s) + 1} - 2\right)}\right)\right] \end{aligned}$$

$$\Theta(K) = \omega \left( \frac{\alpha}{sn_{eff}} (K + \rho s + z s) \right) \left( 1 - 2^{-\frac{\alpha}{2sn_{eff}}(K + \rho s + z s)} \right) erfc \left( \sqrt{3 \cdot 10^{\gamma_{eff}/10} / \left( 2^{\frac{\alpha}{sn_{eff}}(K + \rho s + z s) + 1} - 2 \right)} \right)$$

$$11 \quad \times \left[ 2 - \left( 1 - 2^{-\frac{\alpha}{2sn_{eff}}(K + \rho s + z s)} \right) erfc \left( \sqrt{3 \cdot 10^{\gamma_{eff}/10} / \left( 2^{\frac{\alpha}{sn_{eff}}(K + \rho s + z s) + 1} - 2 \right)} \right) \right]$$

$$- \left[ 1 - \left( 1 - W(s, z, K, k) \varepsilon_s^{\frac{1}{k(0.5 \cdot sz + 1)}} \right)^{1/\alpha} \right]$$

12  
 13 wherein  $p_{QAM}$  represents a probability of error in transmitting a  
 14 quadrature-amplitude-modulation waveform representing a  $2^b$  point constellation, and  $p_e$   
 15 represents a channel symbol error rate; and  
 16 comparing the value of  $\Theta(0)$  and  $\Theta(N_{max}-\rho s-sz)$  to 0; and  
 17 setting the value of K to a predetermined value in response to the comparing.

1 | Claim 22 (currently amended): The method of claim 21-18 wherein when  $\Theta(0) < 0$  and  
 2 |  $\Theta(N_{max}-\rho s-sz) < 0$ , setting  $K = N_{max}-\rho s-sz$ .

1 | Claim 23 (currently amended): The method of claim 18 further comprising:  
 2 | setting  $b(\gamma_{eff}, s, z)$  equal to  $(\alpha N_{max})/(s n_{eff})$  for all values of  $\gamma_{eff}$  and  $z$ .  
 3 |

$$4 \quad \frac{\alpha N_{max}}{s n_{eff}}.$$

1 | Claim 24 (original): The method of claim 18 wherein when  $\Theta(0) > 0$  and  
 2 |  $\Theta(N_{max}-\rho s-sz) > 0$ , setting  $K = N_{max}-\rho$ .

1 | Claim 25 (currently amended): The method of claim 24 further comprising:  
 2 | setting  $s=1$  and  $z=0$   $b(\gamma_{eff}, s, z)$  equal to  $b(\gamma_{eff}, 1, 0)$ .

1      Claim 26 (currently amended): An apparatus for determining an optimum bit load per  
2      subchannel in a multicarrier system with forward error correction, comprising:

3      means for computing a number of bit positions  $b$  of a  
4      quadrature-amplitude-modulation symbol based on one or more values of one or more  
5      values of a maximum number of symbol errors that can be corrected  $t$ , and a number of  
6      symbols in the information field  $K$  and one or more values of a number of control code  
7      symbols per discrete-multi-tone symbol  $z$ , to provide one or more determined values of  $b$ ,  
8      to determine the optimum bit load per subchannel in accordance with the following  
9      relationship:

$$1 - \left( 1 - W(s, z, K) \varepsilon_s^{\frac{1}{0.5 \cdot sz + 1}} \right)^{1/\alpha} \\ = \omega(b(\gamma_{\text{eff}}, s, z)) \left( 1 - 2^{-b(\gamma_{\text{eff}}, s, z)/2} \right) \operatorname{erfc} \left( \sqrt{3 \cdot 10^{\gamma_{\text{eff}}/10} / (2^{b(\gamma_{\text{eff}}, s, z)+1} - 2)} \right), \text{ and} \\ \times \left[ 2 - \left( 1 - 2^{-b(\gamma_{\text{eff}}, s, z)/2} \right) \operatorname{erfc} \left( \sqrt{3 \cdot 10^{\gamma_{\text{eff}}/10} / (2^{b(\gamma_{\text{eff}}, s, z)+1} - 2)} \right) \right]$$

$$W(s, z, K) = \left[ \frac{\Gamma(K + s + sz)}{\Gamma(K + s + 0.5 \cdot sz) \Gamma(0.5 \cdot sz + 1)} \right]^{-1/(0.5 \cdot sz + 1)}$$

$$W(s, z, K) = \left[ \frac{\Gamma(K + \rho s + sz)}{\Gamma(K + \rho s + 0.5 \cdot sz) \Gamma(0.5 \cdot sz + 1)} \right]^{-1/(0.5 \cdot sz + 1)}$$

$$\text{wherein } \omega(b) = \frac{4}{2b + 3}, \text{ and}$$

$$\Gamma(x) = (x-1)!,$$

21       $s$  represents a number of discrete-multi-tone symbols in a frame,  $\varepsilon_s$  represents a symbol  
22      error rate,  $\alpha$  represents the size of a code symbol,  $\rho$  represents a framing mode index,  $z$

23     represents a number of control code symbols per discrete multi-tone symbol,  $b$  represents  
24     a number of bit positions of a quadrature-amplitude-modulation symbol,  $\omega(b)$  represents  
25     an average fraction of erroneous bits in an erroneous  $b$ -sized  
26     quadrature-amplitude-modulation symbol,  $\gamma_{eff}$  represents an effective signal-to-noise  
27     ratio, and  $n_{eff}$  represents an effective number of subchannels; and  
28         means for selecting the value of  $K$  and the value of  $z$  which provides a maximum  
29         number of bit positions based on the one or more determined values of  $b$  the maximum  
30         number of symbol errors that can be corrected  $t$ , and the number of symbols in the  
31         information field  $K$  such that the uncoded bit error rate  $p_b$  that produces a symbol error  
32         rate that is less than or equal to the target symbol error rate is increased.

1     Claim 27 (original): The apparatus of claim 26 wherein the effective signal-to-noise  
2     ratio  $\gamma_{eff}$  is an average signal-to-noise ratio of at least a subset of the channels.

1     Claim 28 (currently amended): The apparatus of claim 26 wherein the size of the frame  
2     ranges from 0 to  $N_{max}$ -s-zs symbols, where  $N_{max}$  is a predetermined value.

1     Claim 29 (currently amended): The apparatus of claim 26 further comprising:  
2         means for determining a difference  $\Theta(K)$  between a bit error rate prior to  
3         decoding and ~~at~~ the target bit error rate ( $p_e$ ) based on one or more values of a length of an  
4         information field  $K$  within a range from 0 to  $N_{max}$ -ps-sz, where  $N_{max}$  is a predetermined  
5         value, in accordance with the following relationship:

$$\Theta(K) = \omega(b(\gamma_{eff}, s, z))p_{QAM} - p_e, \text{ and}$$

9

$$\omega(b(\gamma_{\text{eff}}, s, z)) p_{QAM}$$

$$= \omega\left(\frac{\alpha}{sn_{\text{eff}}}(K + s + zs)\right) \left(1 - 2^{-\frac{\alpha}{2sn_{\text{eff}}}(K+s+zs)}\right) \operatorname{erfc}\left(\sqrt{3 \cdot 10^{\gamma_{\text{eff}}/10} / \left(2^{\frac{\alpha}{sn_{\text{eff}}}(K+s+zs)+1} - 2\right)}\right)$$

$$\times \left[2 - \left(1 - 2^{-\frac{\alpha}{2sn_{\text{eff}}}(K+s+zs)}\right) \operatorname{erfc}\left(\sqrt{3 \cdot 10^{\gamma_{\text{eff}}/10} / \left(2^{\frac{\alpha}{sn_{\text{eff}}}(K+s+zs)+1} - 2\right)}\right)\right]$$

10

11

$$\omega(b(\gamma_{\text{eff}}, s, z)) p_{QAM}$$

$$= \omega\left(\frac{\alpha}{sn_{\text{eff}}}(K + \rho s + zs)\right) \left(1 - 2^{-\frac{\alpha}{2sn_{\text{eff}}}(K+\rho s+zs)}\right) \operatorname{erfc}\left(\sqrt{3 \cdot 10^{\gamma_{\text{eff}}/10} / \left(2^{\frac{\alpha}{sn_{\text{eff}}}(K+\rho s+zs)+1} - 2\right)}\right)$$

$$\times \left[2 - \left(1 - 2^{-\frac{\alpha}{2sn_{\text{eff}}}(K+\rho s+zs)}\right) \operatorname{erfc}\left(\sqrt{3 \cdot 10^{\gamma_{\text{eff}}/10} / \left(2^{\frac{\alpha}{sn_{\text{eff}}}(K+\rho s+zs)+1} - 2\right)}\right)\right]$$

13

14

$$p_e = \left[1 - \left(1 - W(s, z, K) \varepsilon_s^{\frac{1}{0.5 \cdot sz + 1}}\right)^{1/\alpha}\right]$$

15

16 wherein  $p_{QAM}$  represents a probability of error in transmitting a

17 quadrature-amplitude-modulation waveform representing a  $2^b$  point constellation, and  $p_e$

18 represents a channel symbol error rate; and

19 means for comparing the value of  $\mathcal{O}(0)$  and  $\mathcal{O}(N_{\max}-s-zs)$  to 0; and

20 means for setting the value of K to a predetermined value in response to the

21 means for comparing.

1 Claim 30 (currently amended): The apparatus of claim 2926 wherein when  $\mathcal{O}(0) < 0$  and

2  $\mathcal{O}(N_{\max}-s-sz) < 0$ , said means for setting sets  $K=N_{\max}-s-zs$ .

1      Claim 31 (currently amended): The apparatus of claim 30 further comprising:

2      means for setting  $b(\gamma_{eff}, s, z)$  equal to  $(\alpha N_{max})/(s n_{eff})$  for all values of  $\gamma_{eff}$  and  $z$ .

3

4      
$$\frac{\alpha N_{max}}{s n_{eff}}$$

1      Claim 32 (currently amended): The apparatus of claim 30 wherein when  $\Theta(0) > 0$  and

2       $\Theta(N_{max}-s-sz) > 0$ , said means for setting sets  $K = N_{max}-1$ .

1      Claim 33 (currently amended): The apparatus of claim 32 further comprising wherein

2      said means for setting sets  $s=1$  and  $z=0$   $b(\gamma_{eff}, s, z)$  equal to  $b(\gamma_{eff}, 1, 0)$ .

1      Claim 34 (currently amended): An apparatus for selecting forward error correction  
2      parameters in a channel having a plurality of subchannels in a multicarrier  
3      communications system, comprising:

4      means for determining a signal-to-noise ratio representing a subset of the  
5      subchannels to provide ~~said~~ a representative performance measurement;  
6      means for storing, in a table, the number (s) of discrete multi-tone symbols in a  
7      forward-error-correction frame, the number (z) of forward-error-correction control  
8      symbols in the discrete multi-tone symbol associated with the signal-to-noise ratio, and  
9      the number of subchannels associated with the signal-to-noise ratio, and a net coding gain  
10     for different values of s, z, signal-to-noise ratios and numbers of subchannels; and  
11     means for selecting forward error correction parameters of the channel based on  
12     the net coding gain by applying an approximation to a subset of values in the table.

1      Claim 35 (original): The apparatus of claim 34 wherein the approximation is a bilinear  
2      approximation.

1       Claim 36 (currently amended): An apparatus for selecting forward error correction  
2       parameters in a channel having a plurality of subchannels in a multicarrier  
3       communications system, comprising:  
4               means for determining a signal-to-noise ratio representing a subset of the  
5               subchannels to provide said a representative performance measurement;  
6               means for storing, in a table, the number (s) of discrete multi-tone symbols in a  
7               forward-error-correction frame, the number (z) of forward-error-correction control  
8               symbols in the discrete multi-tone symbol associated with the signal-to-noise ratio, the  
9               maximum number of transmissions (k) and the number of subchannels associated with  
10          the signal-to-noise ratio, and a net coding gain for different values of s, z, signal-to-noise  
11          ratios and numbers of subchannels; and  
12               means for selecting forward error correction parameters of the channel based on  
13          the net coding gain by applying an approximation to a subset of values in the table.

1       Claim 37 (original): The apparatus of claim 36 wherein the approximation is a bilinear  
2       approximation.

1       Claim 38 (original): The apparatus of claim 36 wherein the values of s and z are in  
2       accordance with the G.dmt standard.

1       Claim 39 (original): The apparatus of claim 38 wherein the values of s and z are in  
2       accordance with the G.lite standard, such that a subset of the tables associated with the  
3       values of s and z in accordance with the G.dmt standard are used when the channel uses  
4       the G.lite standard.

1       Claim 40 (original): An apparatus for increasing a bit load of a multicarrier system  
2       comprising a channel having a plurality of subchannels, comprising:  
3               means for determining a bit load for at least one subchannel based on a target symbol  
4               error rate  $\epsilon_s$ , a maximum number of symbol errors that can be corrected t, a number of

5 symbols in an information field K, and a maximum number of transmissions k, and a number  
6 of bits per subchannel; and

7 means for selecting the maximum number of symbol errors t, the number of symbols  
8 in the information field K and the maximum number of transmissions k, such that a net  
9 coding gain is increased wherein the means for also selects t, K and k such that no forward  
10 error correction is applied when the number of subchannels exceeds a predetermined  
11 threshold number of subchannels.

1 Claim 41 (currently amended): An apparatus for determining an optimum bit load per  
2 subchannel in a multicarrier system with forward error correction, comprising:

3 means for computing one or more values of a number of bit positions b of a  
4 quadrature-amplitude-modulation symbol based on one or more values of a number of  
5 symbols in an information field K, one or more values of a number of control code  
6 symbols per discrete-multi-tone symbol z, and a maximum number of transmissions k, to  
7 provide one or more determined values of b, maximum number of symbol errors that can  
8 be corrected t, and a number of symbols in the information field K to determine the  
9 optimum bit load per subchannel in accordance with the following relationship:

$$1 - \left( 1 - W(s, z, K) \epsilon_s^{\frac{1}{0.5 \cdot sz + 1}} \right)^{1/\alpha}$$

11  $= \omega(b(\gamma_{eff}, s, z)) \left( 1 - 2^{-b(\gamma_{eff}, s, z)/2} \right) erfc \left( \sqrt{3 \cdot 10^{\gamma_{eff}/10}} / \left( 2^{b(\gamma_{eff}, s, z)+1} - 2 \right) \right), \text{ and}$   
 $\times \left[ 2 - \left( 1 - 2^{-b(\gamma_{eff}, s, z)/2} \right) erfc \left( \sqrt{3 \cdot 10^{\gamma_{eff}/10}} / \left( 2^{b(\gamma_{eff}, s, z)+1} - 2 \right) \right) \right]$

12

$$13 W(s, z, K) = \left[ \frac{\Gamma(K + \rho s + sz)}{\Gamma(K + \rho s + 0.5 \cdot sz) \Gamma(0.5 \cdot sz + 1)} \right]^{-1/(0.5 \cdot sz + 1)}$$

$$\begin{aligned}
 & 1 - \left( 1 - W(s, z, K, k) \varepsilon_s^{\frac{1}{k(0.5sz+1)}} \right)^{1/\alpha} \\
 & = \omega(b(\gamma_{\text{eff}}, s, z)) \left[ 1 - 2^{-b(\gamma_{\text{eff}}, s, z)/2} \right] \operatorname{erfc} \left( \sqrt{3 \cdot 10^{\gamma_{\text{eff}}/10}} / \left( 2^{b(\gamma_{\text{eff}}, s, z)+1} - 2 \right) \right) \\
 & \quad \times \left[ 2 - \left( 1 - 2^{-b(\gamma_{\text{eff}}, s, z)/2} \right) \operatorname{erfc} \left( \sqrt{3 \cdot 10^{\gamma_{\text{eff}}/10}} / \left( 2^{b(\gamma_{\text{eff}}, s, z)+1} - 2 \right) \right) \right]
 \end{aligned}$$

$$W(s, z, K, k) = \left[ \frac{\Gamma(K + \rho s + sz)}{\Gamma(K + \rho s + 0.5 \cdot sz) \Gamma(0.5 \cdot sz + 1)} \right]^{-1/(0.5 \cdot sz + 1)} \left[ \frac{\Gamma(K + \rho s + sz + 1)}{\Gamma(K + \rho s + 0.5 \cdot sz) \Gamma(0.5 \cdot sz + 2)} \right]^{-(k-1)/(0.5 \cdot sz + 1)k}$$

$$b(\gamma_{\text{eff}}, s, z) = \frac{\alpha}{sn_{\text{eff}}} (K + \rho s + sz)$$

wherein  $\omega(b) = \frac{4}{2b+3}$ , and

$$\Gamma(x) = (x-1)!, \quad x > 0$$

s represents a number of discrete-multi-tone symbols in a frame, z represents a number of control code symbols per discrete multi-tone symbol, b represents a number of bit positions of a quadrature-amplitude-modulation symbol,  $\varepsilon_s$  represents a symbol error rate,  $\alpha$  represents the size of a code symbol,  $\omega(b)$  represents an average fraction of erroneous bits in an erroneous b-sized quadrature-amplitude-modulation symbol,  $\gamma_{\text{eff}}$  represents an effective signal-to-noise ratio, and  $\rho$  represents a number of overhead symbols per discrete multi-tone symbol framing mode index; and  $n_{\text{eff}}$  represents an effective number of subchannels; and

means for selecting the value of K and z to provide a maximum number of bit positions based on the one or more determined values of b the maximum number of symbol errors that can be corrected t, and the number of symbols in the information field

36 | ~~K such that the uncoded bit error rate  $p_b$  that produces a symbol error rate that is less than~~  
 37 | ~~or equal to the target symbol error rate is increased.~~

1 Claim 42 (original): The apparatus of claim 41 wherein the effective signal-to-noise ratio  
 2  $\gamma_{\text{eff}}$  is an average signal-to-noise ratio of at least a subset of the channels.

1 Claim 43 (currently amended): The apparatus of claim 41 wherein the size of the frame  
 2 ranges from 0 to  $N_{\max}\cdot\rho s\cdot sz$  symbols, where  $N_{\max}$  is a predetermined value.

1 Claim 44 (currently amended): The apparatus of claim 41 further comprising:  
 2 means for determining a difference  $\Theta(K)$  between a bit error rate prior to  
 3 decoding and ~~at~~ the target bit error rate ( $p_e$ ) in accordance with the following relationship:

$$\Theta(K) = \omega(b(\gamma_{\text{eff}}, s, z)) p_{QAM} - p_e,$$

$$\begin{aligned} & \omega(b(\gamma_{\text{eff}}, s, z)) p_{QAM} \\ &= \omega\left(\frac{\alpha}{sn_{\text{eff}}}(K + \rho s + z s)\right) \left(1 - 2^{-\frac{\alpha}{2sn_{\text{eff}}}(K + \rho s + z s)}\right) \operatorname{erfc}\left(\sqrt{3 \cdot 10^{\gamma_{\text{eff}}/10} / \left(2^{\frac{\alpha}{sn_{\text{eff}}}(K + \rho s + z s)+1} - 2\right)}\right) \\ & \quad \times \left[2 - \left(1 - 2^{-\frac{\alpha}{2sn_{\text{eff}}}(K + \rho s + z s)}\right) \operatorname{erfc}\left(\sqrt{3 \cdot 10^{\gamma_{\text{eff}}/10} / \left(2^{\frac{\alpha}{sn_{\text{eff}}}(K + \rho s + z s)+1} - 2\right)}\right)\right] \end{aligned}$$

$$\begin{aligned} \Theta(K) &= \omega\left(\frac{\alpha}{sn_{\text{eff}}}(K + \rho s + z s)\right) \left(1 - 2^{-\frac{\alpha}{2sn_{\text{eff}}}(K + \rho s + z s)}\right) \operatorname{erfc}\left(\sqrt{3 \cdot 10^{\gamma_{\text{eff}}/10} / \left(2^{\frac{\alpha}{sn_{\text{eff}}}(K + \rho s + z s)+1} - 2\right)}\right) \\ & \quad \times \left[2 - \left(1 - 2^{-\frac{\alpha}{2sn_{\text{eff}}}(K + \rho s + z s)}\right) \operatorname{erfc}\left(\sqrt{3 \cdot 10^{\gamma_{\text{eff}}/10} / \left(2^{\frac{\alpha}{sn_{\text{eff}}}(K + \rho s + z s)+1} - 2\right)}\right)\right] \\ & \quad - \left[1 - \left(1 - W(s, z, K, k) e_s^{\frac{1}{k(0.5 \cdot sz + 1)}}\right)^{1/\alpha}\right] \end{aligned}$$

9  
10 wherein  $p_{QAM}$  represents a probability of error in transmitting a  
11 quadrature-amplitude-modulation waveform representing a  $2^b$  point constellation, and  $p_e$   
12 represents a channel symbol error rate;  
13 comparing the value of  $\Theta(0)$  and  $\Theta(N_{max}-\rho s-zs)$  to 0; and  
14 setting the value of K to a predetermined value in response to the comparing.

1 Claim 45 (currently amended): The apparatus of claim 44[[41]] wherein when  $\Theta(0)<0$   
2 and  $\Theta(N_{max}-\rho s-zs)<0$ , said means for setting sets  $K=N_{max}-\rho s-zs$ .

1 Claim 46 (currently amended): The apparatus of claim 45 further comprising:  
2 means for setting  $b(\gamma_{eff}, s, z)$  equal to  $(\alpha N_{max})/(s n_{eff})$  for all values of  $\gamma_{eff}$  and  $z$ .  
3  
4 
$$\frac{\alpha N_{max}}{s n_{eff}}$$
.

1 Claim 47 (currently amended): The apparatus of claim 41 wherein when  $\Theta(0)>0$  and  
2  $\Theta(N_{max}-\rho s-zs)>0$ , said means for setting sets  $K=N_{max}-\rho$ .

1 Claim 48 (currently amended): The apparatus of claim 47 further comprising wherein  
2 said means for setting sets  $s=1$  and  $z=0$   $b(\gamma_{eff}, s, z)$  equal to  $b(\gamma_{eff}, 1, 0)$ .

1 Claim 49 (new): A method of selecting forward error correction parameters in a channel  
2 having a plurality of subchannels in a multicarrier communications system, comprising:  
3 storing, in one or more tables, a net coding gain for a plurality of values of  
4 signal-to-noise ratios and numbers of subchannels, the net coding gain being based on a  
5 one or the values of the signal-to-noise ratios and one of the numbers of subchannels, a  
6 number (s) of discrete multi-tone symbols in a forward-error-correction frame, a

7       number (z) of forward-error-correction control symbols in a discrete multi-tone symbol, a  
8       maximum number of transmissions (k), for different values of s, z and k;  
9               determining a signal-to-noise ratio representing a subset of the subchannels to  
10      provide a representative performance measurement; and  
11               selecting values of s, z and k based on the representative performance  
12      measurement and the net coding gain by applying an approximation to a subset of the  
13      values in the table.

1       Claim 50 (new): The method of claim 49 wherein the approximation is a bilinear  
2       approximation.

1       Claim 51 (new): The method of claim 49 wherein and the values of s and z are in  
2       accordance with the G.dmt standard.